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*Andromeda*); the moss vegetation, as far as present, consisting of peat mosses (*Sphagnum*). In calcium-poor regions.

(2) Brown moors: treeless, normally more or less wet and overflowed, without moss ricks, moderately poor in large shrubs; the moss vegetation, as far as present, consisting principally of so-called brown mosses (various *Amblystegia*, *Hypnum trichoides*, *Paludella*, *Meesia*, *Cinclidium*, etc.). In calcium-rich regions.

(3) Shrub moors: little, or scarcely, overflowed moors with or without ricks, with more or less abundant vegetation of moderately tall shrubs; the moss vegetation being formed principally of Sphagneae and the forest growth, nearly always present, consisting principally of more or less twisted and dwarfed pines (*Pinus silvestris*). In calcium-poor and calcium-rich regions. The ground water more or less stagnant, or very slow-flowing.

(4) Tree moors: forest moors, the woody growth consisting of spruces (*Picea excelsa*) and broad-leaved trees, the pine unimportant; the moss vegetation consisting normally of peat moss and bear moss (*Polytrichum commune*) or with true mosses in increasing numbers. The ground water more or less distinctly flowing. In calcium-poor and calcium-rich regions.

The origin of the Finnish moors is to be attributed to the filling of shallow lakes and lake basins with encroaching plants and to the invasion of moor-forming plants into flooded lands or into forests. The principal moor-forming plants of the first category are *Equisetum fluviatile*, *Carex rostrata*, *Heleocharis palustris*, *Hippuris vulgaris*, *Alisma plantago-aquatica*, *Sparganium simplex*, *Lysimachia thyrsiflora*, *Menyanthes trifoliata*, and a number of hydrophytes, as *Lemna minor*, *Utricularia vulgaris*, and other water plants of the genera *Potamogeton*, *Nymphaea*, and *Nuphar*. Much less frequently, and principally only in southern Finland, appear *Sparganium ramosum*, two species of *Typha*, *Glyceria aquatica*, *Scolochloa arundinacea*, and *Carex stricta*. The remains of all these plants with the mud-covered earth contribute to the formation of the layers of peat. The other method of moor formation by the flooding of river valleys with water is described at some length by Cajander with the aid of maps in the text.

In the development of the moors a variation in the amount of moisture is very frequent. This is observable in the growth of a moor from a shallow lake and in the invasion of a forest by bog mosses and typical moor plants. *Sphagnum fuscum* is one of the principal bog mosses active in raising the ground-water level in the formation of moss ricks. The growth of the Scotch pine on the gray moors, shrub moors, and cotton-grass moors has been studied and plotted by the author in relation to the development of these kinds of moors. The moor complex is then described in great detail, with the aid of outline and colored maps, for the high moors of different geographical types.

The special part of the monograph deals with the types of moors in Finland; and each section, under the headings Gray Moors, Brown Moors, Shrub Moors, and Tree Moors, is introduced with a definition of each type printed in italics. The principal and characteristic plant species are given in detail for each type of moor. Some of the floristic details are listed under the heads of grasses, herbs, shrubs, and trees. The pages fairly bristle with the enumeration of the principal plants which enter into the different moor associations. Each of the twenty plates has two exceptionally clear photographic reproductions of the different kinds of Finnish moors.

The whole monograph is an exceptionally good piece of synecological investigation, and the author has succeeded in throwing considerable additional light upon a much confused subject. It would seem almost necessary to call a convention of ecologists and botanists in order to discuss the nomenclature of moors and bogs with the hope of bringing order out of chaos. Cajander has done a service in discussing the origin, nature, and constituent plants of the Finnish moors without emphasizing the distinction between high moors and low moors and in using other distinctive terms.

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#### THE FORMATION OF CORAL REEFS

T. W. VAUGHAN. *Corals and the Formation of Coral Reefs*. Maps, diagrs., ills. *Ann. Rept. Smithsonian Instn. for 1917*, pp. 189-276. Washington, D. C., 1919.

The first part of this paper presents an excellent summary of the anatomy of the coral organisms and of the ecological conditions under which they live. The results of many experiments by Vaughan, Mayor, and others on the conditions affecting coral growth are cited. Among these may be mentioned the relation to temperature, to light, to the salt content of the ocean, the capacity of corals to withstand exposure to the air, the method by which they catch their food and the nature of their food sup-

ply, the rearing of coral larvae, the duration of the free-swimming stage, and the rate of growth. The conditions for the vigorous development of reef-forming species are indicated.

A definition of a coral reef is proposed, and the necessity of distinguishing this type of structure from one composed primarily of calcareous algae is emphasized. An important section is devoted to varieties of limestone which frequently have been confused with coral-reef rock. These are oölitic limestones, shell sand, and limestones made chiefly of foraminiferal and bryozoan tests. Coral reefs are often associated with such deposits, but make up only a small fraction of the total mass. The distribution of the existing reefs is discussed. The reef-forming species are divisible into two biogeographic groups, the Atlantic and the Indo-Pacific. In the early Tertiary, the reef faunas of both oceans were identical, but the development of a land bridge between North and South America during the middle and later Miocene caused the differentiation, which became complete by the Pliocene.

The closing portion of the paper consists of a critical analysis of the important explanations of the origin of the reefs: (1) the Darwin-Dana subsidence theory; (2) the solution-erosion theory of Semper and Murray; (3) the still-stand theory; and (4), the glacial control theory. The solution-erosion theory is shown to be untenable, for solution is not important either in the lagoon or in the reef channels, and in the lagoon itself sedimentation predominates over erosion. The Darwin-Dana theory is discussed in detail especially with reference to the evidences of submergence. Vaughan concludes that "fringing reefs seem uniformly to have unconformable basal contacts," and that "they may form during either emergence or submergence" (p. 237). Barrier reefs and atolls develop on "antecedent flattish basements during and after submergence. . . . This generalization applies to fossil as well as to living reefs" (p. 237). The supporting platforms are believed to have been formed by various processes prior to the appearance of the reefs and independently of coral agencies. The nature of these processes and the manner of submergence have no bearing upon the later growth of the reefs. The formation of atolls by progressive changes in subsiding fringing reefs, as postulated by the Darwin-Dana theory, is theoretically possible, but Vaughan does not believe that actual examples exist.

The writer agrees with Daly that glacial controls have been of the utmost importance in the present development of the reefs. The supporting platforms, which are pre-Pleistocene in age, were subjected to certain modifications by marine abrasion during the lowered sea levels of the glacial period. In certain areas, as in the Fijis, in the Bahamas, and along the Florida coast, reefs are growing on "coastal flats that have been brought below sea level by tilting" (p. 238). From this Vaughan infers that "general submergence because of deglaciation is concomitant with local crustal deformation" (p. 237).

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#### SECLAR CHANGES IN RAINFALL

C. E. P. BROOKS. **The Secular Variation of Rainfall.** Map. diagrs. *Quart. Journ. Royal Meteorol. Soc.*, No. 191, Vol. 45, 1919, July, pp. 233-248 (discussion, pp. 246-248). London.

It has again and again been asserted that meteorological records present no evidence of secular changes in rainfall. In the present paper Mr. C. E. P. Brooks, however, vigorously attacks this idea. His method is to use departures of rainfall from normal as one factor and the length of time before or after the central year of a given series of observations as the other factor. In this way it is possible to use the exact mathematical method of correlation coefficients. Mr. Brooks has gone to the great labor of working out some two hundred of these coefficients. On this basis he has prepared a map of the world showing the general tendency of the rainfall during the period since observations are available. While there are many coefficients too small to be significant, there are enough large ones to indicate certain general tendencies. The map shows: (1) a marked increase of rainfall in the main land mass of eastern Europe and northern and central Asia and a hint of the same thing in Canada; (2) a general decrease in low latitudes from about 40°N. to nearly the same latitude in the southern hemisphere; and (3) a hint of increased rainfall in the far south. Although the whole matter is still in its initial stages, Mr. Brooks seems to have demonstrated that opposite kinds of changes in rainfall are actually taking place in different parts of the world in cycles longer than any for which complete records are yet available.

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